System, lifting device and method for supporting a pipe string

The present invention relates to a system for supporting a pipe string comprising at least one pipe element, the supporting device and a method for supporting the pipe string.

On many occasions there is a need to support a pipe string consisting of at least one pipe element while an additional pipe element is being connected to the pipe string. An example of such an occasion is the installation of casings in an oil well, but it may also be in connection with the assembly of drill strings or the installation of risers, water pipes etc.

A casing that has to be installed in a drilling oil well or other types of pipe strings usually consists of a plurality of pipe elements which are connected at the installation site, while being lowered into the cavity where it is to be employed/installed. A pipe element is lifted by a lifting device such as a crane on the deck of the installation structure and inserted into the cavity. The lifting device is usually attached to the end of the pipe string and when an additional pipe element has to be attached to the pipe string, the pipe string has to be supported in a different manner than by the lifting device, while one end of a new pipe element is attached to the pipe string. When the pipe element is attached to the pipe string, the lifting device must be attached once more to the free end of the pipe string, thus enabling the pipe string with the new pipe element to be lowered further into the cavity. During installation a casing, for example, is normally passed through a through-going opening in the installation deck. To support the drill string, a bushing with an internally conical surface is normally placed manually around the drill string in the through-going opening. Slips consisting of a plurality of wedge elements are manually disposed by the personnel in the gap between the pipe string and the bushing. The pipe string is then lowered by the lifting device, thus causing the slips to engage with the bushing and the pipe string, thus securing the pipe string securely by means of the wedge effect. The lifting device is then released from the pipe string. A new pipe element is secured to the pipe string and the lifting device is secured to the free end of the additional pipe element, i.e. the free end of the pipe string. By means of the lifting device the pipe string is then raised slightly so that the slips disengage from the pipe string and the slips are lifted manually away from the pipe string by the personnel. The pipe string is thus released for further lowering into the cavity until the process has to be repeated for connecting yet another pipe element to the pipe string.

This is a very hard job physically for the personnel and also entails a certain amount of risk of injury to the personnel involved in setting and removing the slips.

The object of the present invention is to make the work simpler and easier for the personnel while reducing the risk to the personnel. It is also an object to provide a

simple device which can rapidly be employed for supporting pipe strings and which is or can be easily adapted for use with a number of pipe diameters.

This is achieved by the features of the invention indicated in the following claims.

The system according to the invention comprises a lifting device, a wedge device and an abutment element where the lifting device comprises an attachment foundation, a lifting arm with an inner and an outer arm portion, which inner arm portion is in linked connection with the attachment foundation. A replaceable tension element in the form of a circular arc is movably mounted on the outer arm portion. The wedge device is releasably secured to the tension element.

The system is so designed that the wedge device can be moved by means of the lifting device from an inoperative position in a position partly enclosing the pipe string and above the abutment element to an operative position where the wedge device is in abutment with the abutment element and encloses the pipe string, thus securing the pipe string by means of the wedge effect.

The wedge device in the system will normally comprise two or more wedge elements where the wedge elements are individually connected to the tension element. A variant may also be envisaged where the wedge elements are permanently and/or releasably interconnected and where only some of the wedge elements are secured to the tension element, or other variants of these solutions.

In an active position the wedge device will be in abutment against the abutment element, completely encircling the pipe string, with the result that it experiences a uniform wedge effect round its entire circumference and does not suffer damage, etc. Wedge devices for supporting a drill string are well known and will therefore not be discussed further.

The tension element in the lifting device is removably attached to the lifting arm and can be adapted to the diameter of the pipe that has to be supported. The attachment foundation comprises attachment devices for releasable attachment of the attachment foundation to the abutment element and/or a base. These attachment devices may be of any suitable type, but should preferably be of a type that can be released without the use of tools.

The abutment element will also normally be segmented, thus enabling it to be inserted in and removed from its position round the pipe string even when the pipe string is supported in an overhanging lifting device for the pipe string.

The invention also relates to a lifting device for lifting a wedge device in connection with pipe connection of several pipe elements. The lifting device comprises an attachment foundation, a lifting arm and a replaceable tension element. The lifting arm has an inner arm portion pivotally connected to the

attachment foundation and in a first preferred embodiment an outer substantially U-shaped arm portion. A different shape may also be envisaged for the outer arm portion, but the shape must preferably be such that two parts of the arm extend on each side of the pipe string when it is employed. This means that the arm portion may well be V-shaped or have a shape similar to the cross section of a graduated cone, where the open portion faces away from the inner arm portion. The tension element is substantially in the form of a circular arc and is releasably, pivotally connected to the outer arm portion. In this case too a more U-shaped form may be envisaged for the tension element. The wedge device that has to be lifted is releasably attached to the tension element for lifting out of and into an active position.

In a preferred embodiment the tension element comprises a ring element in the form of a circular arc. The tension element in the cross section of the ring may be of different shapes such as round, square or some other shape. In a preferred embodiment the open portion of the circular arc is substantially equal to or slightly smaller than the pipe diameter of the pipe element that has to be supported. The tension element's length, moreover, is substantially equal to the outer circumference of the pipe element of the pipe string that has to be supported.

In an alternative embodiment the length of the tension element may conceivably be greater than the outer circumference, with the result that the ends of the tension element overlap each other and the wedge device is adapted to such overlapping.

The tension element is designed with flexibility so that it is compressed into a circle when the wedge device is in an active position, with a result that the tension element experiences a pre-tensioning. The result of this is that when the wedge device is withdrawn from an active position, the tension element returns to its original unloaded shape while at the same time pulling the wedge device slightly away from the pipe string. The flexibility in the tension element is also of such a nature that a person will easily be able to press the ends of the tension element slightly apart, thus enabling the lifting device to be pulled away from the pipe string.

In the preferred embodiment stoppers are mounted on the tension element's ends of the circular arc. The function of the stoppers is to keep the wedge device's wedge elements in position relative to the tension element. These stoppers may be of any kind known in the art, and may also comprise devices for supporting the two ends relative to each other when the wedge device is in an active position.

In the preferred embodiment a bracket is attached to the preferred U-shaped arm portion near the bottom of the U-shape and a central point of the tension element's circular arc is rotatably connected to the bracket. Furthermore, the outer parts of the U-shaped arm portion are connected to at least two points on the tension element by

at least two flexible connecting elements. In the preferred embodiment there are two connecting elements and these are mounted at opposite sides of the tension element. The connecting elements may, for example, be chains, but may also be ropes, wires, etc.

In order to help the tension element to return to its original taut form after the wedge device has been in an active position, the attachment points for the connecting elements on the lifting arm have a greater distance between them than the attachment points for the connecting elements on the tension element. This helps the tension element to return to its original shape, with the result that in a passive position the wedge device is at a distance from the pipe string.

Instead of a solution with a bracket and two connecting elements, solutions may be envisaged with, for example, four connecting elements evenly distributed between the U-shaped arm portion and the tension element, and other solutions may also be envisaged.

The wedge device may comprise wedge elements which together form a slips assembly. In an embodiment these wedge elements have through-going holes at an end opposite the end that provides the wedge effect and are inserted onto the tension element in the amount required to encircle the pipe string in an active position.

The invention also relates to a method for releasable supporting of a pipe string during connection of a new pipe element to the pipe string as indicated in the following claims.

The invention will now be explained in greater detail by describing an embodiment with references to attached drawings, in which:

fig. 1 is a side view of the system according to an embodiment of the invention,

fig. 2 is a view from above of the lifting arm and the tension element in fig. 1, and

figs. 3 and 4 are two side views of the system in two positions, an active and a passive position.

Fig. 1 illustrates a system according to the invention with a lifting device 1, a wedge device 3 and an abutment element 4, for supporting a pipe string 2 (not shown in figures 1 and 2). Figures 1, 3 and 4 indicate that two wedge elements 31 are positioned, which are two of several wedge elements that form a complete wedge device 3. The wedge device 3 and the wedge elements 31 are already known and will therefore not be explained further here.

The lifting device 1 comprises an attachment foundation 10 and a lifting arm 11 pivotally connected to the attachment foundation 10.

In the illustrated embodiment the attachment foundation 10 is elongated in shape and connected to the abutment element 4. The attachment foundation 10 may equally well be of a different shape such as more square or rectangular, and it need not be directly connected to the abutment element 4. What is important is that it is supported in a stable position relative to the abutment element 4 for implementation of the supporting process. A solution may be envisaged here where the foundation 10 is attached to the deck or the lifting arm 11 is directly linked to other foundation structure in the deck area round the pipe string 2 that has to be supported. At the same time it is an advantage to have direct connection between abutment element 4 and lifting device 1 both in order to achieve correct positioning of the individual elements in the system and also to balance the lifting device 1. Another possible embodiment is to design the attachment of the lifting arm 11 to the attachment foundation 10 in such a manner that the lifting arm 11 can be moved along a track on the attachment foundation 10 (not shown in the figure) for correct alignment of the lifting arm 11 relative to the abutment element 4. Such a track may comprise locking devices for securing the lifting arm 11 in the track, and it may also include markers for securing the lifting arm 11 at special points for different diameters of the pipe string 2.

As illustrated in fig. 2 the lifting device 1 has a lifting arm 11 comprising an inner arm portion 12 which is linked to the attachment foundation 10. In the embodiment the link joint is composed of a link joint which provides rotation of the lifting arm 11 about a substantially horizontal axis. It is also conceivable for the lifting arm 11 to be connected to the attachment foundation 10 by a link joint which provides rotation of the lifting arm 11 about a substantially horizontal and possibly also a substantially vertical axis, while the lifting arm 11 can be rotated about its own longitudinal axis, i.e. the lifting arm has three degrees of freedom if so desired.

Furthermore, the lifting arm 11 has an outermost portion 13, hereinafter called outer portion, at the end of the arm 11 facing away from the attachment to the attachment foundation 10. In the embodiment the outer portion 13 is U-shaped, but other shapes may be envisaged which are of such a nature that they accommodate the pipe string in a space, such as, for example, a V-shape or a circular arc shape, etc. A tension element 14 is releasably secured to this outer arm portion 13. In the embodiment the tension element 14 is composed of a ring element in the form of a circular arc, with the open section 15 of the circular arc facing the pipe string 2. Normally, the open section 15 of the circular arc will be substantially equal to or slightly smaller than the diameter of the pipe string 2 that has to be supported. The length of the tension element 14 will normally be substantially equal to the circumference of the pipe string 2 that has to be supported. The tension element 14 may be made of, for example, spring steel, thus enabling it to be moved between a circular arc shape as a passive form of the tension element 14 and a closed circle assumed by the tension

element 14 when the wedge device 3 is in an active position. In the closed position the tension element 14 will be pre-tensioned with the result that it attempts to expand when the wedge device 3 is released from its active position.

By means of the circular arc shape of the tension element 14 and the U-shape of the outer portion 13 of the lifting arm 11, the lifting device 1 can be moved towards the pipe string 2, thus enabling the wedge device 3 to come into engagement round the whole pipe string 2 while no assembly of equipment is required round the pipe string 2. The lifting device 1 according to the invention can easily be lifted or pushed into position relative to the pipe string 2 before it can be used.

In the embodiment illustrated in the figures the tension element 14 is secured to the lifting arm 11 by a rotatable connection to a bracket 17 which is fixed to the lifting arm 11 near the bottom of the U-shape of the outer portion 13. The bracket 17 may be attached to both arm portions, 12 and 13 respectively, of the lifting arm 11. In different embodiments the bracket 17 may be connected in an easily releasable manner to the lifting arm 11 or the tension element 14 may be connected in an easily releasable manner to the bracket 17. What is important is that the tension element 14 can be easily replaced. A tension element 14 may also be envisaged of such a design that it fits a great number of different diameters on the pipe string 2. This may be implemented, for example, by parts of the tension element 14 being adapted to overlap one another when the wedge device 3 is in an active position.

In the embodiment the tension device 14 is also connected by two flexible connecting elements 18 to two points at the outer ends of the U-shaped portion 13 of the lifting arm 11. In the embodiment these connecting elements 18 are illustrated as chains, but other solutions may be envisaged such as wires, rope, etc. The essential thing is to obtain a certain degree of flexibility in the connection between the lifting arm 11 and the tension element 14 while the tension element 14 is supported substantially in the correct position relative to the abutment element 4. The attachment points for the connecting elements 18 are provided at opposite sides of the tension element 14 and the spacing between the attachment points on the outer arm portion 13 is greater than the spacing between the attachment points on the tension element 14.

As illustrated in fig. 2, at the ends of the tension element there are provided two stoppers 16, which are mounted on the tension element 14 to hold the wedge device 3 in position, thus preventing it from sliding off the tension element 14 during use.

In the embodiment in figs. 1 and 2 the lifting device is also equipped with jack rings, thus enabling it to be lifted and/or pulled away from the pipe string by other lifting gear.

In figs. 3 and 4 two positions are illustrated for the system according to the invention. In fig 3 the system is illustrated in a passive position relative to the pipe string 2 where the tension element 14 with two illustrated wedge elements 31 is depicted in a position above, at a distance from the abutment element 4. In fig. 4 the system is illustrated in an active position where the lifting arm 11 is lowered and the wedge elements 31 are thereby lowered into abutment with the abutment element 4, thus securing the pipe string 2 by means of the wedge effect, and enabling it to be released from its other lifting device (not shown) and permitting an additional pipe element to be secured to the pipe string.

The present invention is described above by means of an embodiment. A number of variations and modifications may be envisaged that fall within the scope of the invention as defined in the following claims.